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THIAMIN AND PLANT GROWTH[1]

By Dr. WILLIAM J. ROBBINS

DIRECTOR OF THE NEW YORK BOTANICAL GARDEN

ALTHOUGH several investigators, including R. J. Williams (1920) and Lepeschkin (1924), had reported a favorable effect of vitamin B_1 or thiamin upon plant growth, their crude preparations contained other substances as well as thiamin, and their results could not be accepted as definitive. Indisputable evidence of the importance of thiamin for plants depended upon the availability of the pure compound. Isolated in crystalline form by Jansen and Donath as early as 1926, thiamin did not become generally available until 1934, largely as the result of the work of R. R. Williams and his associates.

Almost at once Schopfer (1934) demonstrated that *Phycomyces Blakesleeanus* will not grow in a medium of mineral salts, asparagine and sugar unless supplied with thiamin. The demonstration was so striking that further investigations with this organism and with others soon followed until it is now clear as the result of the work of Schopfer, Bonner, Knight and others that thiamin is as necessary in the physiology of plants as it is in the nutrition of animals.

My own interest in thiamin arose from a study of the nutrient requirements of excised roots, initiated in 1917 as the result of a paper by Jacques Loeb in which he suggested that a hormone is concerned in the formation of roots by the leaves of *Bryophyllum calycinum*. It was my opinion that Loeb had not eliminated sugar accumulation in the leaves as the "hormonal" factor, and the experiments on excised roots were initiated to attack that problem directly. In the twenty years since the original experiments a number of people have been associated with me and through their assistance one aspect or another of that problem and related ones

[1] Presented before the Section on the Botanical Sciences of the American Association for the Advancement of Science, Richmond, Va., December 28, 1938.

have been attacked. W. E. Maneval worked with me in the earlier years; E. E. Naylor undertook a morphological and histological study of the origin of the roots of *Bryophyllum* leaves; Albert Saeger studied the necessity of accessory substances for the *Lemnaceae;* Virginia B. White, J. E. McClary and others have assisted in studies on excised roots of *Zea Mays;* Mary B. Schmidt and F. Kavanagh have cooperated in studies of excised tomato roots and of fungi.

Our studies have led us to the conclusion that growth substances are important for plants as well as for animals, that Loeb's original hypothesis is essentially correct, and that one of the important growth substances for plants is thiamin.

Thiamin, also called vitamin B_1 or aneurin, is a definite and specific organic compound of known structure, which is prepared synthetically in commercial quantity. It contains nitrogen and sulfur in addition to carbon, hydrogen and oxygen and is synthesized by combining a pyrimidine, 2-methyl-5-bromomethyl-6-amino-pyrimidine hydrobromide and a thiazole, 4-methyl-5-β-hydroxyethyl-thiazole.

On the basis of our present knowledge it appears that all or almost all plants require thiamin, some of them make it from more elementary materials; others do not and must be supplied with part or all of the thiamin molecule for normal growth. In other words, some plants are autotrophic in their relation to thiamin and others are heterotrophic. In fact, it is possible to divide plants into several groups on the basis of their relation to thiamin. Many kinds require no external supply of thiamin. This group comprises those plants which lack chlorophyll and grow in a medium of mineral salts and dextrose and most, if not all, green plants. It includes, for example, *Aspergillus niger, Agaricus campestris* and *Absidia glauca.* Of 36 saprophytic and parasitic fungi we investigated, the growth of 13 was unaffected by the addition of thiamin to a medium which lacked it. It has been demonstrated that some of these plants which require no external supply of thiamin synthesize it, and it is justifiable to assume that the others in this group also have the same power. It is important to note that the power of synthesis of thiamin is not limited to the green plant but is possessed by yeasts, bacteria and fungi also, because this observation eliminates chlorophyll as a factor essential for the synthesis of thiamin. The green plant is not the sole source of thiamin in nature.

Nearly 100 bacteria, yeasts and fungi are now known to require an external supply of thiamin or its intermediates for normal growth; and further investigation will doubtless materially increase this number. Some of these organisms are saprophytes, but most of them, as might be anticipated, are parasites; the fungi include representatives of the *Phycomycetes, Ascomycetes, Basidiomycetes* and *Fungi Imperfecti.* These plants which require an external supply of thiamin and are unable to make thiamin from the more elementary constituents of the medium differ considerably in their synthetic power. Some are able to construct the pyrimidine portion of the thiamin molecule but not the thiazole part; these must be furnished with the thiamin thiazole for growth. Very few organisms are known in this group. Others can make the thiazole but not the pyrimidine portion of the molecule; these are more common. Some are unable to construct either the pyrimidine or thiazole but can combine the two into the necessary thiamin molecule. *Phycomyces Blakesleeanus* is an example of this group. Finally, there are some plants, for example, most of the *Phytophthoras,* which are so specialized that they are unable to make the thiamin molecule from the thiazole and pyrimidine intermediates. These organisms must be supplied with thiamin as such and resemble in this respect the higher animal. *Rhizopus nigricans* requires no external supply of thiamin, and its growth is inhibited by the addition of thiamin to the medium.

It appears very probable that thiamin is necessary for the growth of all or nearly all organisms. Some of them, however, are capable of making the thiamin they need; some must be supplied with thiamin as such, and between these two extremes there are many gradations in synthetic power. Even closely related organisms may differ in their synthetic power, as has been found for the species of *Ustilago* by Schopfer.

Furthermore, a particular organism under one set of conditions may make sufficient thiamin for normal growth and under another set be unable to do so. We found this to be true for the fungus *Pythium Butleri,* which can not grow in a concentrated salt solution without thiamin but in a more dilute solution constructs sufficient for moderate growth.

The higher plant requires special consideration. Through the technique of cultivation of excised roots of higher plants under sterile conditions it has been possible to demonstrate that although an entire tomato plant synthesizes thiamin, the root does not; it depends upon the shoot for its supply of this essential material. Tomato roots synthesize the pyrimidine portion of thiamin but require an external supply of thiazole. We have maintained excised tomato roots in a solution of mineral salts, pure cane sugar and thiamin for 25 successive passages extending over a period of more than two years and in a solution of mineral salts, pure cane sugar and the thiamin thiazole through 19 passages extending over 20 months. In the same solution without thiamin or thiazole no growth occurs. This extended period of cultivation of excised tomato roots in a synthetic medium is of significance not only from the standpoint of their requirement for growth sub-

stances, but also because the nitrogen requirements of the roots during this period were met by nitrates, thus demonstrating that the root of a higher plant can synthesize its proteins from nitrates. Pea roots, as shown by Bonner, resemble *Phycomyces* and require both intermediates. It is clear that the parasitic relation of the root to the shoot involves more than sugar.

This observation raises the question as to how thiamin should be classified so far as plants are concerned. For the tomato plant, thiamin is a hormone, it is formed in the top of the plant and materially affects the development of the root; for *Phytophthora cinnamomi* it is not a hormone, since no part of the plant produces it. We are not justified in calling it a vitamin for the plant, if we hold to the original definition of this term, which limited it to animal nutrition. Depending upon the organism concerned, thiamin may be considered to be a hormone, a vitamin or something which is neither a hormone nor a vitamin. For the time being I have preferred to refer to it and similar substances by the general term "growth substance," meaning a specific organic substance needed in small amounts for the normal development of a living organism.

Thiamin is needed in small amounts. For example, *Phycomyces Blakesleeanus* shows a measurable response to less than three millionths of a milligram and excised tomato roots to one billionth of a milligram.

Functions of Thiamin. Although required in small amounts, thiamin is not to be regarded as merely a stimulant. It plays a definite and significant rôle in the metabolism of carbohydrates and probably in other metabolic processes also. Lohman and Schuster (1937) and others have demonstrated that thiamin combines with phosphoric acid to form thiamin pyrophosphate or cocarboxylase, which in association with a specific protein is concerned in the decarboxylation of pyruvic acid, an important intermediate in the metabolism of dextrose. There is some evidence to show that cocarboxylase is oxidized to thiochrome and that the thiochrome is ineffective or much less effective than thiamin or cocarboxylase, probably because the change of cocarboxylase to thiochrome is not readily reversible. We have found that a substance with the characteristic blue fluorescence of thiochrome appears in mineral-sugar solutions containing thiamin in which tomato roots have been grown and that thiochrome is much less effective with tomato roots than either thiamin or cocarboxylase. It appears, therefore, that one at least of the functions of thiamin is to serve as a precursor of a part of an enzyme system involved in respiration and that it is eventually rendered inactive.

It is probable that this is not the sole function of thiamin. As Williams and Spies point out in their excellent book on Vitamin B_1 it is reasonable to suppose that thiamin has a multiple function as a coenzyme in nature. The best-established ones are the two known reactions of its pyrophosphate, which in association with one protein can bring about a decarboxylation of pyruvic acid to acetaldehyde or in association with another protein can promote a simultaneous dehydrogenation and decarboxylation of pyruvic acid to form acetic acid. It may also have a purely oxidative function and be concerned in the transformation of carbohydrate to fat. At any rate, it seems clear from the work of Peters and others that in a deficiency of thiamin the catabolic metabolism of dextrose beyond the point of pyruvic acid is interfered with.

We have found that *Phycomyces* makes more growth in a medium lacking thiamin if the carbon source is acetaldehyde, ethyl alcohol or acetic acid than it does in a similar medium in which the carbon source is sugar. This might be anticipated if it is remembered that thiamin pyrophosphate is believed to function in the transformation of pyruvic acid to acetaldehyde and to acetic acid. By using carbon compounds simpler than pyruvic acid the need for the changes in dextrose to these simpler compounds is eliminated; in one sense the acetaldehyde, ethyl alcohol and acetate represent predigested food for *Phycomyces*. However, even with these simpler compounds the growth is distinctly limited and is materially improved by the addition of thiamin. In fact, we have been unable to maintain *Phycomyces* in a sodium acetate medium through more than the first transfer, which suggests that the growth made in the sodium acetate solutions is at the expense of thiamin supplied in the spores used as inoculum. If this is correct, the interesting conclusion follows that thiamin is more effective with sodium acetate as a carbon source than with sugar. Our inability to maintain *Phycomyces* in a sodium acetate solution, and the beneficial effects of thiamin on growth in solutions containing alcohol, acetaldehyde or acetate supports the belief mentioned above that thiamin functions also in ways other than the transformation of pyruvic acid.

These observations, though fragmentary and incomplete, suggest that *Phycomyces* may be used with advantage in determining more completely the changes which occur in the intermediary metabolism of carbohydrates. Furthermore, the presence of acetate or similar substances may affect the bio-assay for thiamin by *Phycomyces*.

The Specificity of Thiamin. The discovery of the enormous effect of thiamin on the growth of some plants naturally raised the question as to its specificity. This is particularly pertinent in view of the experience with the auxins. Investigations with *Phycomyces*, tomato roots, pea roots and *Staphylococcus aureus* have shown that thiamin is quite specific. No success has

yet attended attempts to replace it with amino acids, various sulfur compounds or by other growth substances, including, among others, indole acetic acid, ascorbic acid, nicotinic acid, lacto-flavine, vitamin B_6, ethylene chlorhydrin, pimelic acid and pantothenic acid. In fact, most changes in its molecular structure render thiamin ineffective; in a few instances they reduce its potency materially. The majority of studies on the relation between structural modifications and effectiveness of thiamin for plants have been carried on by using modifications of the pyrimidine and thiazole intermediates, rather than analogs of the vitamin itself. On the basis of these results it appears, for example, that thiamin is rendered inactive for *Phycomyces* if hydrogen is substituted for the methyl group at position 2 on the pyrimidine ring, all other radicals remaining unchanged. Similar results are secured if oxygen is substituted for the amino group at position 6. Thiamin becomes ineffective for *Phycomyces* if a methyl group is substituted for the hydrogen in position 2 on the thiazole ring, or if acetate, acetamide, ethyl acetate, β-hydroxypropyl, γ-hydroxypropyl, hydrogen or methyl groups are substituted for the β-hydroxyethyl group in position 5; and the activity is reduced to 5 per cent. or 10 per cent. if an ethyoxy radical or chlorine replaces the hydroxyl in the hydroxyethyl group in position 5 on the thiazole ring. It is not possible to discuss here in detail the work which has been done by Knight, Schopfer, Bonner and others on the specificity of thiamin. In our own investigations with *Phycomyces* only one compound of nearly 50 pyrimidines and thiazoles tested was as effective as the vitamin intermediates themselves. This compound has an ethyl group in place of a methyl group at position 2 on the pyrimidine ring. It appears, however, that there is some difference between plants in their responses to different modifications of the thiamin molecule. We are not yet certain whether these modifications function as such or whether the plant is capable of transforming them into thiamin. The specificity of thiamin is doubtless associated in part with its function as a precursor of a part of an enzyme system.

The Biological Assay of Thiamin. Schopfer, Mieklejohn and others have used the growth of *Phycomyces Blakesleeanus* as a means of determining thiamin quantitatively. It is a useful method of considerable accuracy and sensitivity. Since it is being used by various investigators, the following comments based on our experience are pertinent.

Growth of *Phycomyces* in a mineral-glucose medium indicates thiamin or the pyrimidine and thiazole intermediates or both. Growth is not specific for the vitamin as such.

Growth is proportional to the amount of the vitamin and not to the concentration.

Growth is proportional to the amount of the vitamin or to the intermediate present in smaller molecular quantity, provided the mineral salts, sugar or nitrogen supply is not limiting.

The logarithm of the amount of thiamin per flask plotted against the logarithm of the dry weight of the mycelium is a straight line. In a suitable medium this linear relationship extends to 10^{-8} mole of thiamin or a growth of something over 500 mgms of mycelium.

The presence of excess thiazole may influence the results.

The Significance of Thiamin from the Standpoint of Symbiosis and Parasitism. The observations which have been made on the growth in mixed cultures of organisms which lack the ability to synthesize the thiamin molecule or a part of it and those which have the ability is most suggestive from the standpoint of parasitism and symbiosis. We have observed on occasion in our experiments the beneficial effects in a medium deficient in thiamin of a bacterial or pink yeast contaminant on the growth of organisms which require an external supply of thiamin. Our experiments showing that polyneuritis in pigeons may be cured by feeding sufficient amounts of the thiamin intermediates or by injecting them intraperitoneally are probably explained by the synthetic action of microorganisms in the intestinal tract. Schopfer has found that *Rhodotorula rubra,* which synthesizes thiazole but not pyrimidine, and *Mucor Ramannianus,* which synthesizes pyrimidine but not thiazole, grow successfully in mixed cultures in a medium lacking thiamin. In a medium lacking thiamin and biotin Kögl and Fries grew a mixed culture of *Ashbya gossypii* which can not make biotin but makes thiamin and *Polyporus adustus,* which synthesizes biotin but not thiamin.

In spite of the rapid progress which has been made in the last year or two in our knowledge of the relation of thiamin to plants and the light which has been thrown on the general problem of growth substances by this information, there is much more we should like to know about this material and its effect upon plants. What are the conditions influencing its production in the plant? Is the supply of thiamin associated with the shape and extent of the growth curve of a plant? What becomes of thiamin as it is used up by an organism? What functions does it play in the physiology of the organism? Where is it formed in the higher plant and where and how is it translocated? Is its production by microorganisms or its possible accumulation in an adsorbed condition in the soil of any sig-

nificance in soil fertility, as suggested by Williams and Spies? However, in our enthusiasm, we must not forget that thiamin is not the only growth substance concerned in plant development. For one organism thiamin synthesis may be a limiting factor, while for another biotin, meso-inositol, vitamin B_6, nicotinic amide or some other growth substance may be important and still other plants may require an external supply of more than one. We have found that in a mineral-sugar solution thiamin is the factor limiting the growth of excised tomato roots. In a mineral-sugar-thiamin solution the ability of the tomato roots to synthesize vitamin B_6 becomes the limiting factor. Careful and critical work is necessary, lest we be set adrift in a maze which is none too simple at best.

In any event the investigations on the relation of thiamin to plants promise the possibility of elucidating important questions in general physiology through the study of more easily controlled material than the higher animal. Of all the growth substances probably involved in its development *Phycomyces Blakesleeanus* apparently lacks the ability to synthesize but one, thiamin; the higher animal is unable to make many. It would be difficult to imagine a simpler and more perfect arrangement than *Phycomyces* for studying the function of thiamin. The studies on the relation of thiamin to plants can not help but emphasize that the physiological mechanisms of fundamental processes are much the same in all living organisms, although details differ. It may not be a compliment, but it should be a salutary corrective of undue pride to realize that although *Phytophthora infestans* does not develop beriberi or polyneuritis it requires thiamin in the same form and probably for the same reasons as we do.

OBITUARY

JAMES PLAYFAIR McMURRICH

ON February 9, 1939, at Toronto, Canada, death from coronary thrombosis took suddenly from our midst a famous scientist, Professor James Playfair McMurrich, who was still actively engaged in writing and research, although in his eightieth year. His passing removes a notable and well-known figure from the ranks of biology and anatomy. But many happy memories of his inspiration and leadership remain, while a large number of accomplished researches and outstanding achievements are a lasting memorial of his exceptional ability combined with untiring application.

Professor McMurrich was born at Toronto on October 16, 1859, the youngest of eight children of the Honorable John McMurrich, M.L.C. and Janet Dickson McMurrich. He matriculated from Upper Canada College and early showed his brilliance of mind and interest in science by obtaining the degree of B.A. at the University of Toronto (1879) before he was twenty years old. Two years later (1881) he also obtained the M.A. and was beginning to write articles for scientific journals.

He now began his career as a teacher, and during the first three years he completed his work for the degree of Ph.D., which was awarded him by Johns Hopkins University in 1885. Later, in recognition of his attainments he received the honorary degree of LL.D. from the Universities of Michigan (1912), Cincinnati (1923) and Toronto (1930).

His academic career, while only one phase of his remarkable existence, was in itself a notable one. His fame early went abroad, and changes of position were rapid. The diversity of his earlier teaching posts gives evidence of his versatility and knowledge. He was successively professor of biology, Ontario Agricultural College, 1882–84, instructor in mammalian anatomy, Johns Hopkins University, 1884–86; professor of biology, Haverford College, 1886–89; docent and assistant professor of animal morphology, Clark University, 1889–92, and professor of biology, University of Cincinnati, 1892–94.

During this period an invitation came to him to become professor of anatomy at Yale. This he declined because he felt it outside of his province. When a similar invitation was proffered by the University of Michigan, however, he decided that its significance should not be unheeded, and he accepted, thus making a radical change in his career. This position he retained for thirteen years, 1894–1907, finally returning to his alma mater, the University of Toronto, in 1907, as professor of anatomy, which post he filled brilliantly until his retirement as professor emeritus in 1930 at the age of seventy.

Professor McMurrich made many firm and lasting friends amongst his colleagues, was loved and respected by his students and was stimulating to his staff. He worked consistently for the advancement of the universities to which he was attached, furthered the cause of science and promoted research. As a result of this policy he was instrumental in founding the School of Graduate Studies in the University of Toronto, which grew rapidly under his oversight, for he presided over its council in the honored position of the first dean for eight years, 1922–30, until his retirement.

His scholarship was profound, his memory phenomenal and his mind was forever active, keen and inquiring. His interests covered a great variety of subjects, many of them far beyond his professional field, and his accumulated knowledge was ever a source

of wonder and admiration to others. But with all his gifts he was never ostentatious, a becoming modesty gracing all his actions. His mind was so active that he was continually working, studying, investigating. He was an ideal research worker and coupled his genius with such diligence and industry that he carried on and brought to completion much valuable and original research work.

His writings comprise a total of 107 publications on widely divergent subjects. Amongst them are five main groups. The first shows his biological interest, which continued throughout his life, and made him a noted specialist on the morphology, phylogeny and classification of the Actinozoa. Specimens from the deep-sea expeditions of the *Siboga* and the *Albatross* were referred to him for study.

The second group of papers comprises numerous studies on fishes, culminating in a series on the salmon and halibut done while a member of the North American Committee on Fisheries Investigation and also of the Biological Board of Canada. Of this latter body he was chairman for several years during its period of most active development. In this connection he was the honored official representative of Canada at the Pan-Pacific Congress in Sydney, Australia, in 1923.

Embryology, both human and comparative, formed a very keen interest on which much work was done, including the writing of a text-book on the "Development of the Human Body," which ran through seven editions.

A fourth interest of course was anatomy, human and comparative. In this field appeared a text-book of "Invertebrate Morphology," four editions of the Sobotta-McMurrich "Atlas of Human Anatomy," the editing of the fourth edition of Morris' "Human Anatomy" and the writing of the sections on the muscular and vascular systems in Piersol's "Human Anatomy."

The final interest, which became stronger with time and was his main activity after retirement from teaching, was the history of anatomy. Here he produced a notable book, "Leonardo da Vinci—the Anatomist." Well advanced at the time of his death was a large work on the history of anatomy. Professor McMurrich read the classics fluently, as well as modern languages, and even added Arabic to his accomplishments in later years, so that he might read original sources for his history.

He was a great believer in the benefits of organized bodies to further science. He joined many societies in which he took an active part and became a member of their executive boards. He was president of the American Society of Naturalists, 1907, and the American Association of Anatomists, 1908. In the year 1922 he was simultaneously president of the American Association for the Advancement of Science and the Royal Society of Canada.

He was an instructor at the Marine Biological Laboratory, Woods Hole, early in his career, and later became a trustee. For years he served on the advisory board of the Wistar Institute of Anatomy and Biology. Other executive positions were held in the American Society of Zoologists and the Royal Canadian Institute, and he was a member of the Royal Microscopical Society, the American Philosophical Society, London Zoological Society, Academy of Sciences and the Osler Club. In all these he took an active part at times. His strength and physical endurance were truly remarkable and were surprising to those who knew him because he never gave the impression of possessing robust health. He was tall and thin in build, of keenly intellectual appearance, and had a mind always demanding much of his vitality. His interests were always objective, never subjective.

Two fraternities were honored in possessing him as a member, Alpha Omega Alpha Honorary Medical Society and Nu Sigma Nu Medical Fraternity. The latter bestowed on him its rare order of merit and elected him president of its honorary council for two years.

Professor McMurrich had a very human side to his life which made him loved as well as respected. He took great pleasure in meeting people and forming new friendships. He was loyal to all his friends and held their affection. His strict integrity and uprightness commanded the respect of all, while his courtesy and kindliness made him very attractive. He was fond of golf, had a passion for travel, took pleasure in his club memberships and was interested in his church. He showed a completely developed, well-rounded personality that took in every normal phase of life.

In 1882 he married Miss Katie M. Vickers. For fifty loyal, happy years they were constant companions, and the happiness of his home no doubt aided materially in raising Professor McMurrich to his high pinnacle of success. A son and a daughter survive him.

Professor McMurrich's eighty years were filled with the wonderful satisfaction that comes from the fullness of life. He lived fully in every way, he achieved great things, he saw his efforts in many fields come to success, he was honored during his lifetime and appreciated for his accomplishments. And last, though not least, at his passing many mourned, but at the same time carried with them the memory of a great man, whose impressive intellectual ability, honor, integrity, grace and kindliness form a noble inspiration to us all.

J. C. WATT

UNIVERSITY OF TORONTO

CARLOS CLYDE GOFF

1905–1939

In the death of Carlos Clyde Goff, assistant entomologist, on January 13, 1939, the Florida Agricultural Experiment Station lost an unusually fine young man; one whose broad interests and enthusiasm have contributed much to the work of the station and promised more for the future. His quiet friendliness, his kindly wit and his unfailing good humor endeared him to all who knew him.

Mr. Goff's contributions have been in entomology, animal ecology, herpetology and mammalogy. His work for the Experiment Station was the study of the vertebrate pests of Florida crops, and at the time of his death work was under way on the pocket gopher; the land turtle, or Florida gopher; and the Florida field mouse.

Mr. Goff was born on October 2, 1905, at Charleston, Ill. He received his B.S. degree from the University of Illinois in 1928. He continued at the university until 1930, serving between 1927 and 1930 as an assistant entomologist with the State Natural History Survey. He went to Florida in 1930, and his M.S. degree from Illinois was awarded *in absentia* in 1931. In 1934 Mr. Goff took further work at the University of Michigan in mammalogy and herpetology. During his stay at Michigan he completed the course work and preliminary examination for a Ph.D. degree and his research work on field mice was to have been reported as a thesis.

Mr. Goff was a member of the American Society of Mammalogists, the Ecological Society of America, the American Society of Ichthyologists and Herpetologists, the Wild Life Society, the Florida Entomological Society, and the Florida Academy of Sciences.

Mr. Goff's wife died in January, 1937. Besides his daughter, Eva Harriet, Goff is survived by his parents, Mr. and Mrs. J. F. Goff, of Charleston, Ill.; a brother, Joseph, also of Charleston; and a sister, Mrs. Reece Bell, of Oakland, Ill.

Marion N. Walker
Florida Agricultural Experiment Station, Leesburg

RECENT DEATHS

Dr. Herman Schneider, professor of civil engineering, dean of the College of Engineering and Commerce and director of the School of Applied Arts and of the Institute of Scientific Research of the University of Cincinnati, died on March 28 at the age of sixty-seven years.

Baron Joji Sakurai, president of the Imperial Academy and of the National Research Council of Japan, from 1882 to 1919 professor of chemistry at the University of Tokyo, died on January 28 at the age of eighty years.

Nature announces the death of Dr. H. M. Dawson, professor of physical chemistry in the University of Leeds, on March 11, aged sixty-three years; of Dr. C. M. Jessop, emeritus professor of mathematics in the University of Durham, on March 9, aged seventy-six years; of Dr. Giuseppe Cesàro, formerly professor of mineralogy in the University of Liège, a past-president of the Belgian Academy of Sciences; of Marcel Godechot, professor of chemistry and dean of the faculty of sciences of the University of Montpellier, aged fifty-nine years, and of Dr. A. M. Hocart, professor of social anthropology in the University of Cairo, on March 9, aged fifty-five years.

SCIENTIFIC EVENTS

THE INSTITUTE OF GEOLOGY OF VENEZUELA

The Instituto de Geología in Caracas, Venezuela, was formally opened on September 15, in the presence of President López Contreras, of Venezuela. Classes began that day with a registration of twenty-four selected students.

The institute is fully equipped for the training of students in the fields of general geology, petroleum geology and mining geology. It is housed in its own building, which contains a large lecture hall, several recitation rooms, separate laboratories for chemistry, mineralogy, petrography, paleontology and economic geology, a drafting room, a research laboratory for the staff, a preparation room for the cutting, grinding and polishing of specimens and thin sections and a workshop. Also included in the institute are a paleontologic museum and a large library. All the laboratories are equipped with the latest apparatus for the investigation of geologic problems.

In addition to courses in mineralogy, economic geology, petroleum geology, paleontology, stratigraphy, sedimentation, field geology, etc., basic courses in chemistry, physics, botany and zoology, mathematics, drafting, hygiene, mining and petroleum laws and language are given. The institute also has its own physician, who, in addition to his medical duties, will teach hygiene.

The institute as at present constituted will give a bachelor's degree in geology at the end of four years study, half of the fourth year being spent in the field. It is planned, later on, to extend the scope of the institute so as to be able to grant higher degrees.

While the institute is a part of the Ministry of

National Education, it has been organized by a committee of professional geologists from the Ministry of Industries' Geological and Mining Service. These men, trained in Europe or the United States, now form the board of regents. They are: Drs. V. M. López, *chairman;* M. Tello; P. I. Aguerrevere; Santiago E. Aguerrevere, and G. Zuloaga. The faculty includes: N. B. Knox, technical director and professor of geology; Ely Mencher, professor of paleontology; Bela Murakosy, professor of topography, and Hermann Kaiser, professor of chemistry.

There are no tuition fees for Venezuelans, but candidates must pass examinations in mathematics, chemistry, physics, biology, English and French before being admitted. The course is four years and leads to a degree. Six scholarships have been granted to students from other North and South American countries. Many of the students are on scholarships provided by the oil companies operating in Venezuela, which give the student not only cash to live on but opportunity for field and laboratory work during vacations.

N. B. KNOX,
Director of the Institute

THE TROPICAL STATION OF THE MISSOURI BOTANICAL GARDEN

THE Missouri Botanical Garden, like all similar institutions which are solely dependent for support upon rentals from business property and returns from investments, has suffered a sharp reduction in its income during the past years. Unlike many institutions, the cost of maintaining the estate, city taxes, annual bequests, etc., must all be deducted before money is available for maintaining the numerous activities of the garden. Since the budget must be balanced, the only way to do this is to reduce expenses or increase resources.

An appeal for contributions to a "Friends of the Garden Fund" will shortly be made and it is hoped that this may result in restoring the income to something like it was ten years ago. In the meantime one of the economies which has regretfully been enforced is the abandonment of the Tropical Station on the Canal Zone.

This station was established in 1926, at the time the Powell orchids were acquired, and through the years has been a most helpful adjunct in building up the orchid collection. Recently the station has been the headquarters for expeditions for plants other than orchids, looking towards a more complete study of the flora of Panama.

The Canal Zone Government is taking over the station and will maintain it as a park for the benefit of residents and tourists. Fortunately Paul Allen, formerly manager of the station, will remain in the employ of the Canal Zone, and will be able to act as the tropical representative of the garden. This will make possible the continuation of the work on the flora of Panama, and it is hoped that because of the facilities still available this project will not suffer unduly because of the station ceasing to be an adjunct of the garden.

SCIENCE AT THE NEW YORK WORLD'S FAIR

ACCORDING to an official statement recently issued by authorities of the New York World's Fair, "Science, one of the fundamental principles on which the New York World's Fair has been built, will have a special display of its own, portraying its influence on the individual, the family, education and social life." Dr. Albert Einstein is chairman of the Advisory Committee on Science. He is cooperating with Dr. Gerald Wendt, director of science and education, in endeavoring to present "a dramatically visual program that will be understandable and revealing to the average layman." The exhibit, sponsored jointly by the fair corporation and the American Association for Adult Education, also will include education "as a force in the never-ending search for truth, standing between civilization and disaster." One of the seven exhibits under Science and Education will occupy 10,000 square feet of space in a triangular structure, which will house the "Hall of Man," containing the exhibits on medicine and public health. The official announcement states that "The twin exhibit will deal with ideas, with the true nature of science and education and with their social implications. In the first exhibit the purpose will be to show the 'secret of success' that has brought science to the fore. In the latter exhibit will be featured the responsibility of citizens in a democracy to keep pace with this changing world and the necessity for regarding education as a life-long process. There will be no effort to 'teach' science or to compete with the fascinating commercial exhibits, since science pervades practically every department of the fair. Similarly, in education there will be no exhibit of 'school work,' of school materials or of specific educational institutions."

Museum News describes the building of the New York Zoological Society, which is a one-story structure with a great ball at one corner for showing the "Bathysphere," in which Dr. William Beebe made his deep-sea observations, accompanied by specimens and models of deep-sea fish, and with special bays at another corner for a large habitat group and at one end for the cage of the society's giant panda. At the entrance to the building will be two dioramas showing the effect of time on zoological life, the dioramas representing the New York area a million years ago and to-day. Other exhibits will show brilliantly colored species of

living birds and fish contrasted with colorless animals, an electric eel with explanation of how its electricity is generated and used, an insect group and a battery of motion picture projectors showing a series of zoological films. At the exit is a room devoted to information concerning the society, its activities and its objectives. The enterprise is financed by a group of trustees of the society, and is administered by a separate corporation formed for the purpose.

THE AWARD OF GUGGENHEIM FELLOWSHIPS

THE John Simon Guggenheim Memorial Foundation has announced the award of sixty-nine fellowships amounting to $150,000. The recipients were chosen from among more than a thousand applicants.

The fellowships are granted to scholars, artists and scientific workers who by their previous work have shown themselves to possess unusual ability. Men and women, married and unmarried, of all races and creeds, who are citizens or permanent residents of the United States, are eligible on equal terms. The fellows are usually of ages between twenty-five and forty years. This year their average age is thirty-six years. They may work anywhere in the world where their work can best be done. Forty-three of the fellows just appointed intend to work abroad in whole or in part. The stipends are usually $2,500 a year.

The fellows chosen are resident in twenty-two states, only five of which are in the East. They were born in twenty-four states and eight foreign countries. Fourteen of the fellows are not college-trained. Forty-seven are members of the faculties of colleges and universities, and twenty-two are free-lance scholars and artists. The University of Wisconsin leads with four members of its faculty. The Johns Hopkins University and the Universities of Missouri and California have three each. Purdue University, Sarah Lawrence College, Cornell University, Columbia University and the University of Chicago have two each.

Fellowships awarded in the sciences are:

DR. LAWRENCE R. BLINKS, professor of biology, Stanford University, for investigations of the relations of metabolism to the bio-electric properties of large plant cells.

DR. MAURICE EWING, assistant professor of physics, Lehigh University, his second fellowship, for deep-sea investigations by gravitational and seismic methods.

DR. ISIDORE GERSH, instructor in anatomy, the Johns Hopkins Medical School, for studies of the intracellular distribution of certain organic compounds.

DR. HENRY N. HARKINS, instructor in surgery, Medical School of the University of Chicago, for research into the nature and causes of surgical shock.

DR. LOUIS GEORGE HENYEY, instructor in astronomy, Yerkes Observatory, University of Chicago, to study the theory of the formation of stellar absorption lines.

DR. EARL MARTIN HILDEBRAND, assistant professor of plant pathology, Cornell University, for research on the modes of transmission of certain new virus diseases of fruit plants, with chief emphasis on determining how they are spread by insect carriers.

DR. HUBERT M. JAMES, professor of physics, Purdue University, to make a study of the application of wave mechanics to the computation of intensities in band spectra.

DR. CHARLES W. JONES, assistant professor of English, Cornell University, to study European scientific manuscripts of the eighth to twelfth centuries as preparation for the writing of a history of the physical sciences as they were known in the early Middle Ages.

DR. LELAND S. MCCLUNG, instructor in research medicine, Hooper Foundation for Medical Research, University of California, for studies of certain disease-producing and food-spoiling bacteria.

DR. ALFRED GEORGE MARSHAK, physiologist, formerly associated with the Deaconess Hospital in Boston, for investigations of the mechanism of chromosome division, especially the nature of the chromosome structure as revealed by response to neutron bombardment in the cyclotron at the University of California.

DR. ROSE C. L. MOONEY, associate professor of physics, Newcomb College and Tulane University, for research into the structure of crystals by methods of x-ray analysis.

DR. EARLE HAMLET MYERS, instructor in zoology, Compton Junior College, California, to continue his studies of the life cycles of the Foraminifera, with special reference to the role of these organisms in the sea and their significance in geological formations.

DR. GREGORY PINCUS, visiting professor of experimental zoology, Clark University, for the continuation of his investigations of the developmental physiology of mammalian eggs and embryos.

DR. HILDA FLORENCE ROSENE, assistant professor of zoology, University of Texas, for investigations of the forces and structures involved in the absorption and transport of water by plants.

ADRIAAN JOSEPH VAN ROSSEM, curator of the Dicky Collections, to study the ornithological collections of Europe.

DR. EMIL L. SMITH, instructor in biophysics, Columbia University, for a study of the kinetics and mechanism of photosynthesis.

DR. HAROLD R. SNYDER, instructor in organic chemistry, University of Illinois, for a study of the configuration of nitrogen in organic compounds.

DR. CHESTER STOCK, professor of paleontology, California Institute of Technology, for a vertebrate paleontological reconnaissance of Mexico.

DR. ROBERT C. TRYON, associate professor of psychology, University of California, to write a book on the inheritance of ability to learn, based upon data derived from a series of experiments on the ability of successive generations of rats to learn their way through complicated mazes.

DR. MELVILLE L. WOLFROM, associate professor of chemistry, the Ohio State University, for studies of the general methods of investigating the organic structure of

natural products as carried on in several European laboratories.

DR. OSCAR ZARISKI, professor of mathematics, the Johns Hopkins University, to conduct researches in the theory of algebraic varieties from the standpoint of modern algebra.

THE ABRAHAM FLEXNER LECTURES AT THE MEDICAL SCHOOL AT VANDERBILT UNIVERSITY

DR. ALBERT SZENT-GYÖRGYI, director of the Institute for Medical Chemistry and professor of medical chemistry at the Royal Hungarian Franz Joseph University at Szeged, Hungary, and winner of the 1937 Nobel prize in physiology and medicine, is the Abraham Flexner Lecturer at the Vanderbilt Medical School this year, having arrived at the school on March 4 for a two-month period.

Dr. Szent-Györgyi has visited the United States twice before, first about 1930 as guest of the Mayo Clinic, and in 1935 he returned as a visiting lecturer at the Harvard Medical School.

He has been an active contributor to scientific literature for about twenty years. In his earlier studies he was interested in physico-chemical problems in biology, such as the phenomena of agglutination, cataphoresis and the effect of electrolytes on albumin, and such biochemical problems as the estimation of free fatty acids in blood.

In 1932 he was able to identify vitamin C, the antiscorbutic acid responsible for the elimination and prevention of the condition known as "scurvy," by the use of hexuronic acid (ascorbic acid) derived from adrenal cortex and from cabbage. In 1933 he prepared large quantities of ascorbic acid from paprika, and obtained a crystalline monoacetone derivative. He has also been interested in the wide-spread subclinical vitamin C deficiency in man.

Dr. Szent-Györgyi delivered the following lectures during March: "General Principles of Biological Oxidation," "Respiration of Muscle," "Fermentation and Some Problems of Intermediary Metabolism," "Vegetable Respiration" and "On Vitamins, Health and Disease." During April he will remain at the Medical School as visiting professor of biochemistry.

The Abraham Flexner lectureship was established in 1927 by the brother of Abraham Flexner, Bernard Flexner, who wrote to the chancellor of Vanderbilt University in establishing the endowment: "It is in my mind to set aside certain securities for the medical department of Vanderbilt University. I would like these securities to be held in trust as the 'Abraham Flexner Lectureship,' the accumulated income to be used at intervals of two years or more as an honorarium to be given to some American or foreigner, highly distinguished in the field of the medical sciences; the lecturer to be in residence for the purpose of contact with faculty and students during a period of approximately two months, and to give a series of lectures, the number and character of which shall be determined by the lecturer himself and the university."

SCIENTIFIC NOTES AND NEWS

THE annual meeting of the National Academy of Sciences will be held in Washington on April 24, 25 and 26. As has already been announced, the first lecture in America under the Pilgrim Trust will be given by Sir William Bragg on the evening of Monday, April 24. The sessions for the reading of scientific papers will be held on Monday morning and afternoon, on Tuesday morning and perhaps on Tuesday afternoon. The annual dinner, at which medals and awards are presented, will be on Tuesday evening. Arrangements have been made to visit the Supreme Court of the United States late on Monday afternoon.

THE American Philosophical Society will hold a general meeting in the hall of the society in Independence Square, Philadelphia, on April 20, 21 and 22. Sessions for the presentation of papers will be held on Thursday, April 20, on Friday afternoon and on Saturday morning. There will be an executive session on Friday morning and an open forum for members only on Saturday afternoon. The R. A. F. Penrose, Jr., memorial lecture will be given on Friday evening by Eduard Benes, formerly president of Czecho-Slovakia. The lecture will be followed by a reception. The annual dinner will be on Saturday evening.

THE honorary degree of doctor of humane letters was conferred by Bridgewater College, his alma mater, upon Dr. William T. Sanger, president of the Medical College of Virginia, Richmond, on April 3 when he made the Founders Day address. The honorary doctorate of laws will be conferred upon him at the commencement exercises of the University of Richmond.

ON the occasion of the retirement of Herbert B. Brooks from the National Bureau of Standards on February 1, his colleagues assembled a collection of his published papers and prepared a biographical note "as a mark of their appreciation of him as a skilful engineer, an inspiring friend, and a wise counselor."

A TESTIMONIAL dinner in honor of Dr. Robert L. Swain, secretary-treasurer of the Maryland Board of Pharmacy, was given on March 29 in Baltimore. Dr. Swain recently resigned the position of deputy food

and drug commissioner of the State of Maryland, to accept the editorship of *Drug Topics* and *Drug Trade News*, published in New York.

AT the opening general session of the American Chemical Society, which met at Baltimore from April 3 to 7, presentation of the Borden Award in the Chemistry of Milk was made to Dr. Leroy S. Palmer, professor of agricultural chemistry at the University of Minnesota and dairy chemist at the Experiment Station, and of the Eli Lilly and Company Award in Biological Chemistry to Dr. George Wald, instructor and tutor in biology at Harvard University. Each award is of the value of $1,000.

DR. NORMAN R. F. MAIER, assistant professor of psychology at the University of Michigan, who received the award of $1,000 of the American Association for the Advancement of Science at the Richmond meeting, has received from the university the Henry Russel Award for 1938–39 in recognition of his scientific work. The Russel award and the Henry Russel lectureship were made possible by a bequest of the late Henry Russel, of Detroit, an alumnus of the University of Michigan.

THE Meyer Medal for distinguished services in plant introduction has been awarded by the council of the American Genetic Association to Kate O. Sessions, horticulturist, of San Diego, California. The presentation took place at the Southern California Spring Flower Show, held at Pasadena on April 1, 2 and 3. Miss Sessions, who is now eighty-two years old, has contributed to the horticultural beauty of southern California through fifty years of active work spent there as a landscape gardener and horticulturist. The Meyer Medal had its origin in a bequest by the late Frank N. Meyer, plant explorer of the U. S. Department of Agriculture, who left to his fellow workers in the Office of Foreign Seed and Plant Introduction money for a farewell party in his honor. They elected to use this fund to have a medal struck to commemorate outstanding achievements in plant introduction. The council of the American Genetic Association was appointed the agency to make these awards.

DR. JAMES D. BRUCE, chairman of the division of health sciences of the University of Michigan, was designated president-elect of the American College of Physicians at the recent New Orleans meeting. He will assume office at the next annual convention. Dr. O. H. Perry Pepper, professor of medicine at the University of Pennsylvania, assumed the presidency, succeeding Dr. William J. Kerr, professor of medicine at the University of California. Dr. Allen A. Jones, of Buffalo, was elected first vice-president; Dr. Gerald B. Webb, of Colorado Springs, second vice-president, and Dr. J. Morrison Hutcheson, of Richmond, Va., third vice-president.

ACCORDING to *Nature*, the following have been elected officers of the British Physical Society for the year ending March, 1940: *President*, Professor Allan Ferguson; *Vice-presidents*, Professor G. I. Finch, Dr. Ezer Griffiths, Dr. L. Hartshorn and R. W. Paul; *Honorary Secretaries*, J. H. Awbery and Dr. W. Jevons; *Honorary Foreign Secretary*, Professor O. W. Richardson; *Honorary Treasurer*, Dr. C. C. Paterson; *Honorary Librarian*, Dr. J. H. Brinkworth. The Geological Society of London has elected as *President* Professor H. H. Swinnerton; *Vice-presidents*, Dr. E. B. Bailey, Professor W. G. Fearnsides, Professor O. Jones and Professor C. E. Tilley; *Secretaries*, Dr. Hawkes and Professor W. B. R. King; *Foreign Secretary*, Sir Arthur Smith Woodward; *Treasurer*, F. Ashcroft.

DR. FRANK N. FREEMAN, professor of educational psychology at the University of Chicago, has been appointed chairman of the department of psychology. Concurrently with the appointment, the department has been transferred from the Division of Biological Sciences to the Division of Social Sciences. Professor Freeman succeeds Professor Harvey Carr, who retired last autumn. In the interval, Professor Louis L. Thurstone, Charles F. Grey distinguished service professor of psychology, assumed responsibility for the administrative details of the department pending the appointment of a chairman. The transfer of the department to the Division of Social Sciences for administrative purposes was made because Dr. Freeman is connected with that division. The field of interest of the department will continue to be in both biological sciences and social sciences.

DR. MAURICE N. RICHTER, since 1928 assistant professor of pathology in the College of Physicians and Surgeons of Columbia University, has been promoted to a professorship, and has been appointed executive officer of the department of pathology in the New York Post-Graduate Medical School.

DR. PATRICK H. DREWRY, JR., has been appointed assistant professor of neuropsychiatry at the Medical College of Virginia at Richmond. He is now in London for special study in this field under a fellowship from the Rockefeller Foundation. He expects to begin his work at the college next spring when it is anticipated that the new hospital, which will have an active psychiatric service, will be completed.

DR. J. FISHER STANFIELD, of the department of biology of Knox College, has been appointed assistant professor of botany in the department of science of the Chicago Teachers College. He took up his work there in February.

DR. C. H. O'DONOGHUE, reader in zoology at the University of Edinburgh, has been appointed professor of zoology at the University of Reading, England. He succeeds Professor F. J. Cole.

HAROLD L. MADISON, director of the Cleveland Museum of Natural History, Ohio, retired on April 1.

DR. RICHARD WEISSENBERG, formerly professor extraordinarius of anatomy at the University of Berlin and during 1937 visiting professor of cytology at the School of Medicine, Washington University, St. Louis, has been appointed a member of the Wistar Institute of Anatmoy and Biology, Philadelphia.

DR. HERMAN E. HAYWARD, professor of botany at the University of Chicago, has resigned, effective on March 16, to accept a post with the U. S. Regional Salinity Laboratory at Riverside, Calif.

DR. A. ASHLEY WEECH has been appointed director of the Normal Child Development Study of Columbia University, replacing Dr. Herbert B. Wilcox, who has become director of the New York Academy of Medicine. The appointment took effect on April 1.

M. H. V. VALLOIS, in charge of the anthropological laboratory for practical studies of the Ecole des Hautes Etudes, Paris, since 1937 and professor in the faculty of medicine of the University of Toulouse, has been appointed professor of prehistoric anthropology in the Institut de Paléontologie humaine of the University of Paris. M. Vallois is senior editor of *L'Anthropologie.*

A GRANT of $2,000 from Parke Davis and Company will provide for a year's research at the College of Medicine of Wayne University into the cause and treatment of peptic ulcer. Dr. David Sandweiss and Research Associate M. H. F. Friedman, members of the department of physiology, will be in direct charge of the work. Dr. T. L. Patterson will supervise the research. General investigations of peptic ulcer conducted during the past two years by the department of surgery will be continued in collaboration with the new work.

THE ninth Joseph Henry Lecture of the Philosophical Society of Washington, on "Recent Developments of Cosmic-Ray Investigation," was given by Dr. Thomas H. Johnson, of the Bartol Research Foundation, Swarthmore, Pa.

DR. H. T. DAVIS, professor of mathematics at Northwestern University, will give the academy address at the fifty-third annual meeting of the Iowa Academy of Science at Ames, on April 21. His subject will be "The Philosophy of Science."

PROFESSOR DETLEV W. BRONK, director of the Johnson Research Foundation and of the Institute of Neurology of the University of Pennsylvania, delivered the Louis Clark Vanuxem Lectures at Princeton University from March 20 to 23. The subjects of the several lectures were: "The Social and Biological Significance of the Nervous System," "The Sensory Outposts and Their Messages," "Physical and Chemical Determinants of Behavior Patterns" and "The Cellular Integration of the Organism."

DR. KAZYS PAKŠTAS, professor of geography at the University of Vytautas-the-Great, Kaunas, Lithuania, has been invited to lecture at the summer session of the University of California at Los Angeles from June 26 to August 10 on human and political geography in Central Europe. He plans to spend a year in the United States.

DISCUSSION

A MILITARY CLASSIFICATION FOR FOSSIL FRAGMENTS

PALEONTOLOGISTS have long been forced to use the binominal system in an unorthodox fashion in classifying fossils which are merely parts of an undiscovered, and possibly undiscoverable, organic whole. With increased activity in micropaleontology there come into prominence more and more groups in which zoological relationships may never be determined, so that, if the groups are to be studied at all, strictly artificial classifications *must* be employed.

How important this situation has become may be illustrated by the echinoderms, whose fragments in the form of both holothurian and echinoid spicules, echinoid spines, stelleroid and crinoid ossicles,[1] pedicellariae, fragments of Aristotle's lantern and other isolated plates are being more extensively studied every year. Naturally, if these and other fragments are to have correlative value they must first be classed as so many different bolts, nails or screws regardless of whether or not it can, at the moment, be demonstrated that they were made out of the same metal or in the same factory. But actually most of these groups we now classify as if they were biological units, and give them "generic" and "specific" names.

The infelicities due to the use of these non-biological "genera" also are serious in the more conventional fields of paleontology. Vertebrate paleontologists, for instance, have employed dual classifications long and commonly. Nine "families" and a host of "genera" have been established for fossil vertebrate tracks from the Triassic of the Connecticut River valley alone, and the

[1] R. C. Moore, *Bull. Geol. Soc. Amer.*, 49: 1918, 1938.

"genus" *Cladodus* includes a type of tooth demonstrated to have occurred in as many as seven families of three distinct orders of sharks. The study of fossil plants is also complicated by nomenclatorial difficulties. For instance, the Pennsylvanian genus *Calamites,* whose living representatives obviously grew as botanical entities, is in fragmentary form, catalogued under no less than a dozen "generic" names! Such a situation, annoying enough to the paleobotanist, is confusion confounded to scientists in related fields.

Thus, all divisions of paleontology have their own specific problems of dual classification. The difficulty, however, is a *general* one, and at least some of the problems might be lessened if merely the incubus of the terms "genus" and "species" could be removed. A satisfactory basis for a utilitarian classification, divorced from these terms, is found in the classical divisions of the Roman Army. The *Ordo militaris,*[2] or "Military Classification," with its approximate classificatory equivalents in the Linnaean, or typical binominal system, follows:

Linnaean	*Ordo militaris*		
Class	Exercitus	—plural	Exercitus
Order	Legio	— "	Legiones
Family	Cohors	— "	Cohortes
Genus	Manipulus	— "	Manipuli
Species	Centuria	— "	Centuriae
Individual	Miles	— "	Milites

Since most attempts to devise, for fossils, designations which are assembled as numbers or as formulae have met with little success, there is retained, for the military classification, a binominal scheme of nomenclature with simple Latin and Greek descriptive terms.

The most important terms of the *Ordo militaris* are the equivalents of the genus and species of the biological classification, *i.e., manipulus* and *centuria.* Their substitution for the old terms may seem a little strange at first, but certainly *manipulus* is easier to use than "artificial" or "form" genus, and it involves no contradiction nor misuse of words. The military system is by no means a panacea to cure all nomenclatorial ills, but its use will at least be unambiguous to the extent that its terms themselves reveal that the writer is dealing with fossils which can be grouped under the same name because of their architectural similarities, and not necessarily because of any real or implied "blood relationships."

Under the "military system" not only the neglected fossil fragments, but also the entities, of which the fragments are only a part, would have a better chance of becoming completely understood. The fact, however, that an entire fossil becomes known and is described under a new name in nowise would throw into synonymy the *Ordo militaris* designations for the possibly many different *manipuli* and *centuriae* fragments which made up the whole. The "military system" terms, if applied in conformity to the ordinary rules of nomenclatorial procedure, would continue to have (special) taxonomic standing, and stratigraphic significance. Furthermore, the fossil fragments themselves, in all cases so much more numerous than complete organic remains, having been christened, would have a far better chance of achieving the paleontological importance which they richly deserve.

CAREY CRONEIS

WALKER MUSEUM,
UNIVERSITY OF CHICAGO

[2] *Jour. Geol.*, 46: 7, 975–984, 1938.

REVISION OF DENTAL SYMBOLS

THE symbols employed by anatomists and vertebrate paleontologists in designating the teeth of mammals is in need of revision. Confusion arises from using the same characters for two different purposes. The same characters are employed in one sense to designate the number of teeth in the dental formula and in another sense to designate the position of teeth in the dental series.

The dental formula is fully established and apparently encounters no objections beyond those of the typist and compositor. When, however, symbols employed in the dental formula to designate the number of teeth in a series are used to designate the position of an individual tooth, confusion arises. For example, a paper recently came to my desk in which a generic description ran thus: "Dentition $\frac{I3}{3}$ $\frac{C1}{1}$ $\frac{P4}{4}$ $\frac{M2.}{2}$ $\underline{P4}$ has metacone, etc." In the one instance $\underline{P4}$ indicates that there are four teeth in the premolar series; in the other instance it indicates that the fourth tooth of the premolar series is under discussion. This is common practise, grown up in vertebrate paleontology as a short cut in description.

The form of the symbol used to designate the individual tooth ($\underline{P4}$) is troublesome to the typist and to the compositor. This is true also of the dental formula but that appears as a rule only once in the paper whereas the symbols for individual teeth may run through pages of description and discussion. They will be found at the beginning of sentences and at their end, sometimes at both. This common use renders the symbol a continued source of trouble to the typist because of the need of shifting, and a source of expense to the printer because the symbol can not be set up by machines and must be set up by hand.

Various modifications of the tooth symbol have been suggested. The most satisfactory solution appears to be that of eliminating the dash used as a dividing line in the symbol and bringing the number down on the

line of the initial letter, thus: P4. In that way it has the same form and meaning as a date written, Jan. 4. The several members of the premolar series may be designated as P1, P2, P3, P4. The same is true of other teeth in other series.

Now, having disposed of the dash, it becomes necessary to distinguish between the upper and lower teeth. Let us employ the printer's distinction of upper and lower case. For upper premolars we will use the capital letter as an index to the series, thus: P4, for lower premolars we will use the small letter, thus: p4. This will be found distinctive and the difficulty of typing and type-setting at once disappear. The plan has in its favor the two-fold arguments of distinctness and of economy.

E. S. RIGGS

FIELD MUSEUM, CHICAGO

TERMINAL ZIGZAGS IN SNOWSLIDE STRIATIONS

IN his interesting article on "Snowslide Erosion,"[1] Mr. Dyson invites discussion of the mechanics of the formation of zigzags in the terminal portions of the striae cut by boulders carried in snowslides. It seems probable that this erratic motion of the boulders is brought about by a similar movement of the snow by which they are transported. It has occurred to the writer that the behavior of the snow in this manner may be analogous to that of a viscous liquid upon being poured in a small stream from a moderate height.

As a rather homely example, let us consider the manner in which our breakfast syrup (if we like it thick) behaves when its fall is arrested by the horizontal surface of the pancake. The falling column of syrup does not simply impinge vertically and expand in all directions from the point of contact. Rather, it swings to and fro at the end, laying down an intricate pattern of undulant loops which merge one into another and then spread out over the surface. These loops may sometimes fall with their long axes parallel, but more commonly so that each loop crosses its predecessor at an angle, in which case the end of the falling stream soon assumes a circular motion; seeming to descend in a widening spiral which merges into the surface of the expanding pool of liquid.

The reason for this lateral oscillation in the lower part of a falling stream of thick liquid seems fairly obvious. Briefly, the end of the stream must receive a slight deflection toward one side or another at the moment of contact due to slight irregularities in the surface against which it strikes, so that the stream is bent away from the vertical. If the fluid is sufficiently cohesive internally, this deflection will tend to increase until it reaches a certain amplitude, whereupon it reverses itself. This reversal is due to the fact that the vertically descending portion of the stream surpasses in velocity that which is falling at an angle to the perpendicular and begins to crowd against it so that it is itself deflected from the vertical and in the opposite direction. This new deflection continues to grow until the critical amplitude is again reached, whereupon another reversal occurs. Since the same conditions which give rise to this terminal oscillation also obtain, though to a lessening extent, in the adjacent part of the stream a series of oscillations of diminishing amplitude appears in this region.

Let us imagine this falling stream of syrup confined between two parallel sheets of friction-free glass, sufficiently far apart to permit the stream to fall freely except that its axis must remain oriented in the same plane throughout. Since we are postulating frictionless glass we can probably tip the ensemble to an angle equal to that of the snow slope without upsetting the conditions that cause the oscillatory motion. If the stream were now suddenly to congeal, the figure presented would be not unlike the path of one of the stria-forming boulders. The path of an individual particle in the center of the falling stream of syrup would closely resemble the striae described. Perhaps we may consider the snowslide as a viscous stream confined between the planes imposed upon it by the solid bed and by the gravitational force acting upon it. To the writer it does not seem too fanciful to believe that the moving column of snow may behave in a manner similar to that of the syrup when the forward part of the column is brought to a sudden stop by meeting some obstacle head-on, which obstacle may consist of large rocks, a sharp change in the angle of the slope or simply more snow in a state of rest.

If the analogy here presented be valid, then the zigzags in the snowslide striae should show a greater amplitude near the lower end than at their inception. It should be of interest to inquire of Mr. Dyson whether or not such an increase of amplitude was noted in the final portion of the zigzags at the time of his observations in Glacier Park.

J. ROBERT WELLS

LA OROYA, PERU

A WINTER WHIRLWIND

WHILE driving toward Red Wing, Minn., on the afternoon of November 23, I noticed an old-fashioned whirlwind pass across the road. A slight snow was falling, with the sun visible at some instants. The temperature was 20 degrees above zero and the wind about 8 miles per hour from the northwest. The whirlwind appeared to be the kind I used to see down on the farm in the Ozarks on a warm summer day, except that it was picking up a lot of snow and moving along with the wind. Due to traffic conditions I could not observe any distance up into the air. The whirl

[1] J. L. Dyson, SCIENCE, 87: 365–366, 1938.

was so filled with snow that it was practically impossible to see any objects through it as it passed my path. This may not be of any great interest, but I don't recall reading or hearing about whirlwinds in the winter-time, which accounts for my calling the matter to the attention of the readers of SCIENCE.

H. D. MATTHEWS

MINNEAPOLIS

"TITANS OF THE DEEP"

I WOULD like to correct a rather vital misconception in regard to the film now running in New York City and elsewhere in the country, called "Titans of the Deep." This is being credited to me and my associates, whereas neither I nor any member of my staff of the Department of Tropical Research, nor any one connected with the New York Zoological Society, had anything to do with it.

At the very beginning are shown a few authentic shots of the Bathysphere, but all the rest of the film is the work of Mr. Otis Barton, and was taken in Panama at his own expense and with no relation to the Bathysphere. I never saw any of it until it appeared on a New York screen. Together with my staff, I would like completely to dissociate myself from this motion picture and to have it known altogether as the work of Mr. Barton. In a recent letter he tells me he has been trying to accomplish this correction, but without success.

WILLIAM BEEBE

DEPARTMENT OF TROPICAL RESEARCH,
NEW YORK ZOOLOGICAL SOCIETY

SCIENTIFIC BOOKS

STATISTICAL METHODS

Statistical Methods—Applied to Experiments in Agriculture and Biology. By GEORGE W. SNEDECOR. Collegiate Press, Inc., Ames, Iowa, 1938. xiii + 388 pp. Price $3.75.

IN the preface, the author writes: "It is a pleasure to acknowledge the leadership of Professor R. A. Fisher. . . . By his residence as guest professor in mathematics at Iowa State College as well as through his writings he has exercised a profound influence on the experimental and statistical techniques of the institution." It is not surprising, then, that Snedecor's book should resemble R. A. Fisher's "Statistical Methods for Research Workers" more than it resembles the usual text-book on statistics. And the appearance of a sixth edition of the Fisher book (1936) testifies to the assistance that such a book can render to investigators, especially to those working in biological fields. Fisher's book is a reference book, almost devoid of mathematical proof, giving by detailed examination of numerous problems some of the most important principles of statistical research, with special emphasis upon significance tests. Snedecor's book proceeds along the same general lines, but the latter is a little more informal, it devotes a little more space to making plausible what it does not attempt to prove, and it inserts 417 examples, enough to make it a practical text-book as well as a reference book.

The following three problems taken from the first three chapters will illustrate the type of problem in which the author is most interested:

Example 1.10—An entomologist was trying to adjust the concentration of a spray so as to kill 50% of the flies in a container. Having got what seemed to be a satisfactory mixture, he sprayed a batch of 128 flies, killing 55%. Show that this is not a significant deviation from the 50:50 expectation. 2.30—Assuming that the coefficient of variation of yields in field plot tests with wheat is usually near 5%, would you be surprised if told that in an experiment where the yield was 25 bushels per acre, the standard deviation of plot yield was 0.5 bushel per acre? 3.17—An agronomist interested in the effect of superphosphate on corn yield tried adding the fertilizer to a treatment of manure and lime. Five pairs of plots were tested. The plots with superphosphate yielded 20, 6, 4, 3 and 2 bushels per acre more than their parallels. Was the value of superphosphate demonstrated?

The book contains a number of useful tables for statistical computations. Unfortunately, these are imbedded in the text, instead of being placed in an appendix. Disregarding Table 1.3 as one row of Table 9.1, these tables appear as follows:

Page 58. Values of t at the 50%, 5% and 1% levels. Here t = (Computed average x—Theoretic mean x)/(Computed standard error of the average).

Page 89. Values of the ratio (Range)/(Theoretic standard deviation) for various sample sizes, n.

Page 133. Correlation coefficients at the 5% and 1% levels of significance.

Page 152. Ordinates of the normal curve (4 decimals).

Page 154. Cumulative normal frequency distribution (4 decimals).

Page 163. Chi-square at levels 99%, 95%, 50%, 30%, 20%, 10%, 5%, 1%.

Page 184–187. F = (Larger variance)/(Smaller variance) at 5% and 1%. (Applicable to problems in analysis of variance.)

Page 286. The 5% and 1% points for r and R. (Simple and multiple coefficients of correlation.)

Page 329. Coefficients and polynomials for terminal values and differences for fitting terms up to the seventh degree.

Page 351. Coefficients for sets of independent comparisons for 2, 3, 4, and 5 groups at equal intervals.

Mention also should be made, in this connection, of the chart on page 70 for estimating the size of sample required for significance in group comparisons.

The foregoing tables indicate that the author's interest centers about significance tests. Such tests appear in a study of means, variances, covariances, regressions and correlations, simple or multiple or partial, linear or curvilinear, interclass or intraclass.

Although the book avoids mathematical proof, there are 175 citations, among which appear the names of Bartlett, Brandt, Davenport, Ezekiel, Fischer, R. A. Fisher, Galton, Gauss, Goulden, Irwin, Lipka, Neyman, Pearl, Karl Pearson, Egon Pearson, H. L. Rietz, Sheppard, Snedecor, "Student," W. R. Thompson, Tippett, Wallace, Wishart, Wilks and Yates. Even those who are interested primarily in theoretic probability and statistics may derive considerable benefit from a perusal of such a book as Snedecor's, where detailed consideration is given to particular problems.

EDWARD L. DODD

UNIVERSITY OF TEXAS

THE PHYSICAL WORLD

Our Physical World. By ECHELS, SHAVER and HOWARD. Pp. xi + 801. Benj. H. Sanborn and Company, 1938.

IT appears from what we read in the preface of this book that new light came to this dark world in 1929. The depression was an event which transcended in importance the world war. "Since that time the emphasis in curriculum development has been laid upon improving the philosophy of persons connected with education, such as teachers, pupils, administrators, parents and other adults." After some "innovating experiences resulting from the translation into practice of the improved educational vision of the members of the educational staff" of the Pasadena schools this book resulted. "The written statement comes after the innovating, rather than before it." (The preface was not written by the authors.)

To be brief, this book is now to be used as a text in the instruction of pupils of pre-high-school and high-school age in very elementary physics, chemistry, meteorology, geology, biology, engineering and social science, though these terms are not stressed and the material is slightly intermingled. The nature of the contents can be seen from the headings of the divisions or units: Science Changes our Environment; The Structure of Matter; Radiant Energy in Modern Life; Electricity in the Service of Man; The Action of Atoms; Making New Molecules; The Control and Use of Heat Energy; The World of Sound; The Universal Laws of Motion; The Earth, Man's Abode; The Infinite Universe; The Control of Scientific Achievements. As must be perfectly obvious, the treatment of all these topics in a book of even 800 pages is necessarily qualitative and exceedingly elementary.

The authors are not pioneers in this endeavor. Various high schools and colleges have attempted to present courses in general science. In one college with which the reviewer is acquainted this kind of course, though a more exacting one, was required of all freshmen for about ten years but was finally abandoned.

But these teachers are under obligation to teach general science to a large number of very young students. They must make the subject-matter attractive, they must arouse interest. In the text they discuss each unit topic for forty or fifty pages, then there is an "Interpretation and Review," then "Outcomes" under the headings "Understandings and Meanings," "Attitudes and Appreciations," "Techniques and Skills." After this kind of discussion the method changes and we have "Student Activities in the Laboratory." Here a few experiments are described, but they are not written up in the ordinary matter-of-fact manner. Then there are study questions in all manner of forms, historical and qualitative, true or false, choice of words, similarities and contrasts. Finally, at the end of each unit there are suggestions for teachers, including a list of visual aids, films, slides, charts, references, demonstrations and bibliography.

It looks like a full schedule for the teacher. With so many questions of all kinds coming at him has a student a chance to ask a question? Might not some of the extremely light material be omitted? For example, here are a few questions under one general head. "What experiments would you perform to test whether this is true or false?—Knocking on wood will prevent bad luck. A fat person is always good-humored." (The reviewer will try sticking pins into his fat friends).

There are a few scientific errors: "An electron in the outer part of an atom has just as strong an electrical charge as the positive charge in the nucleus" (p. 216). "Hydrogen atomic weight is the unit or standard of comparison for the weights of all other atoms" (p. 294). "All materials expand when heated and contract when cooled" (p 489). At least one in English, "All these particles are too small *to see.*" (If they were large enough they would see something).

But the book is a serious and, the reviewer thinks, a successful attempt to present to young students some of the chief phenomena of the physical world. With competent and enthusiastic teachers a course of study based on this book should assist such students in acquiring a general knowledge of, and, perhaps what is more important, a lively interest in, nature and nature's laws.

GORDON FERRIE HULL

DARTMOUTH COLLEGE

REPORTS

THE ROCKEFELLER FOUNDATION[1]

DURING 1938 The Rockefeller Foundation appropriated a total sum of over $15,000,000. Of this amount, speaking in terms of rough classifications, $3,800,000 was given to the medical sciences, $3,800,000 to the social sciences, $3,000,000 to the natural sciences, $2,500,000 to public health, $1,000,000 to the humanities and $300,000 to rural reconstruction in China.

The foundation's income during 1938 amounted approximately to $7,000,000. In appropriating $15,000,000 it was necessary, therefore, not only to use up the balance carried over from earlier years, but to dip into the principal fund to the extent of $3,755,000.

In carrying out its 1938 program the foundation operated in forty-two countries in all parts of the world. Eighteen of these countries were in Europe, five in Asia, two in Africa, five in South America, ten in North and Central America and the West Indies and two were islands of the Pacific.

Twenty-five per cent. of the money given went to foreign countries, and the remainder, 75 per cent., was for work in the United States.

It was found advisable in 1938 to make large appropriations to four different institutions. Two of these grants were for current support over extended periods, and two were for endowment. These account, in part, for the relatively large total of funds appropriated during the year. To the China Medical Board, the foundation gave $1,580,000, under an earlier authorization, for expenditure over a period of approximately four years. Previously the foundation had made annual appropriations to this board toward the maintenance of the Peiping Union Medical College. Support over a relatively long period has now been given to enable both the board and the college to plan with reasonable assurance for the immediate future.

To the University of Chicago, the foundation appropriated $1,500,000 for the endowment of biological research. The foundation has made grants for the current maintenance of this work for a number of years, and the program has so clearly demonstrated its quality that stabilization of foundation support seemed wise.

To the American University of Beirut, the foundation appropriated $1,000,000 toward the endowment of its medical school, including nursing and premedical subjects. This action has been in contemplation for a number of years, and it is now believed that the university is in a position to raise the supplementary sums required and thus make a substantial addition to its resources.

To the Spelman Fund of New York, the foundation appropriated $2,000,000 for use over a five-year period in support of the fund's program in public administration. Both the foundation and the Spelman Fund are interested in research and training in public administration. The foundation has given assistance to academic institutions; the fund to non-academic institutions. The latter type of program promises significant results and inasmuch as the resources of the Spelman Fund were practically exhausted, the foundation made it possible for this experienced organization to continue its work over the next five years.

Among other large appropriations and pledges made during the year were the following:

Yale University: toward support of the Institute of Human Relations	$700,000
Washington University School of Medicine (St. Louis): for the maintenance of its departments of medicine, surgery, pediatrics and obstetrics	400,000
Graduate Institute of International Studies, Geneva: toward its general expenses	315,000
State Institute of Public Health, Stockholm: half the cost of construction and equipment	270,000
University of Toronto School of Nursing: endowment	255,000
University of North Carolina: for work in drama: endowment ($150,000); current expenses ($33,000)	183,000
Social Science Research Council: for conferences and planning in connection with research in the social sciences	150,000
University of Chicago: for support of psychiatric teaching and research	150,000
The Johns Hopkins University School of Medicine: toward support of the Institute of the History of Medicine	150,000
Washington University School of Medicine: for support of the Department of Neuropsychiatry	150,000

Except in the field of public health, the foundation is not an operating organization. It conducts no researches of its own. Its activities are confined to grants to other agencies—universities, laboratories and research institutes—and to the training, through fellowships, of competent personnel in the various fields of knowledge.

[1] From review of work in 1938 by Raymond B. Fosdick, president.

SPECIAL ARTICLES

THE DETERMINATION OF ETHYLENE EVOLVED BY APPLES AND PEARS

THE methods described herewith have been developed to fulfil the need for an accurate chemical means for determining the small amounts of ethylene produced by apples and pears. Although several estimations of the amounts of this gas emanating from certain fruits have

been made[1, 2] the procedures used are not adapted to small experimental lots of fruit such as are commonly employed in physiological investigations.

In preliminary studies undertaken, it was considered desirable to determine whether or not saturated hydrocarbon gases as well as ethylene were present in the vapors emanating from the fruit. For this purpose, a method was used by which the evolved hydrocarbon gases were combusted before and after bromination. The apparatus designed for this experiment is shown in Fig. 1.

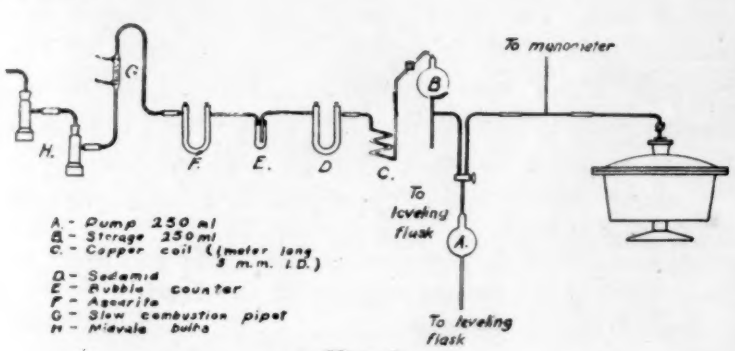

FIG. 1.

The procedure used in making this determination was as follows.

Approximately 1.5–2 kg of fruit, together with 200 ml of 15 per cent. KOH were placed in each of several desiccators, which were then connected to an oxygen supply. After standing for a given period of time at a temperature of 65 degrees F., the KOH was removed and 5 ml of 28 per cent. ammonia solution (to remove acetaldehyde) were introduced into the vessel and allowed to react for one hour. The vapors were then transferred by means of a Topler pump into another container.

The aldehyde-free gas was then equally distributed in two evacuated desiccators. The unsaturated hydrocarbons in one of the vessels were brominated by the addition of 2 ml of liquid bromine. The total hydrocarbons present in the other container were determined by the following procedure.

The gases were extracted from the desiccator by the Topler pump "A" (Fig. 1) and forced into the gas reservoir "B," which was maintained at a slight pressure. By adjusting the stopcock at the top of "B," a constant flow of one liter per hour could be maintained through the analytical train during the entire course of the extraction.

Before the hydrocarbon gases could be oxidized, it was necessary to remove all traces of other organic vapors. This was accomplished by passing the gases through a purification train consisting of a copper coil "C" immersed in a dry ice-ether mixture, a sodamide tube "D," a bubble counter "E," containing phosphoric acid, and an ascarite tube "F." The hydrocarbons, then being the only organic substances left, were oxidized by means of a hot platinum spiral "G,"[3] and the CO_2 resulting was then collected in the Midvale bulb "H" and weighed. This gave the total hydrocarbon content of the vapors. Blank determinations showed that ethyl acetate, ethyl alcohol, ethylene dibromide and acetaldehyde were removed completely by the purification train used, while ethylene passed through and was determined quantitatively.

The vessel containing the brominated vapors was next connected to the analytical train and the gases forced through as described. The excess bromine was removed by a 20 per cent. KOH solution contained in a bubble counter placed between the pump and the desiccator. The data from this experiment gave the saturated hydrocarbon content, the unsaturates being obtained by difference.

Both apples and pears were treated by the above procedure. The results of these determinations before and after bromination show that very little, if any, saturated hydrocarbons occur in the gases evolved by the fruits used. The amounts of unsaturated hydrocarbons (as ethylene) produced by these fruits during ripening are shown in Fig. 2.

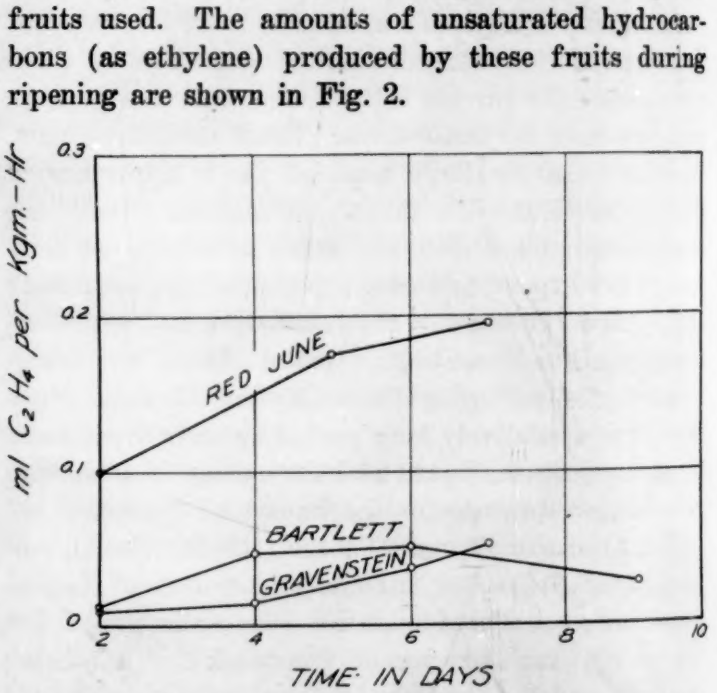

FIG. 2. Ethylene produced by apples and pears at 65° F, determined by slow-combustion method.

Since ethylene or similar olefins appear to be the only hydrocarbon gases present in the fruits used, investigations were undertaken to develop a method by which these could be rapidly and accurately determined. For this purpose, a micro-method was developed by which the ethylene can be determined in a 35 ml gas sample withdrawn from the desiccator at regular intervals during the course of the experiment.

[1] R. Gane. *Jour. of Pomol. and Hort. Sci.*, 13: 351, 1935.

[2] Joseph B. Niederl and Mortimer E. Brenner, *Mikrochemie*, 24: 134–145, 1938.

[3] Bert E. Christensen and Robert Carleton. *Ind. and Eng. Chem. (Anal Ed.)*, 9: 400, 1937.

Using this procedure, the amounts of ethylene produced by several varieties of apples have been determined and are shown graphically in Fig. 3. This

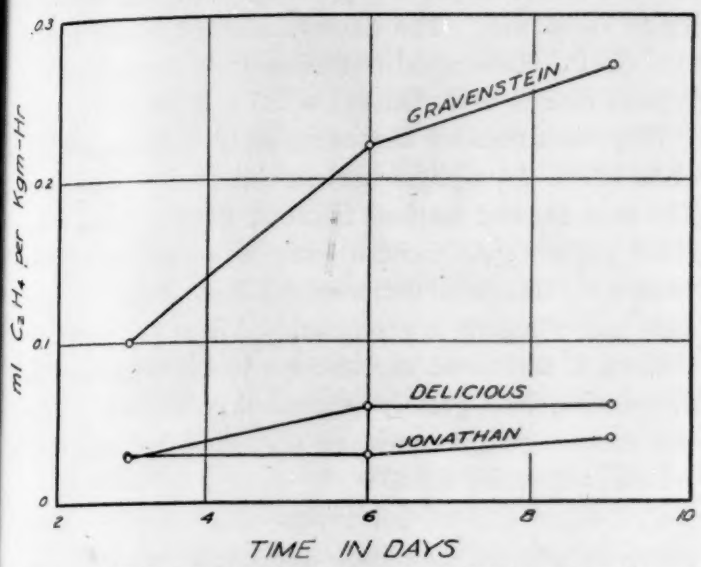

FIG. 3. Ethylene produced by 3 varieties of apples at 65° F, determined by micro-bromination method.

method has the distinct advantage in that a small amount of fruit can be enclosed in a vessel and the ethylene evolved accurately and rapidly determined at regular intervals during the course of any experimental treatment to which the fruit may be subjected. A detailed description will be presented in a forthcoming publication.[1]

BERT E. CHRISTENSEN
ELMER HANSEN
VERNON H. CHELDELIN
J. B. STARK

OREGON STATE COLLEGE,
CORVALLIS, OREGON

ROLE OF HORMONES IN THE SEXUAL REACTION OF HETEROTHALLIC ACHLYAS

THIS communication, a preliminary report of experimental work on an undetermined species of *Achlya*, a genus of the Saprolegniales, more clearly establishes the role of hormones as activators and coordinators in the sexual reaction in the phycomycetous fungi. These hormones, or specific sexual substances, would fall into the group of diffusion hormones or diffusion activators according to the classification of Huxley.[1]

The sexual reaction in this heterothallic species is under hormonal control at least until the time of the formation of the basal wall of the oogonium. In the time which elapses between the approximation of the ♂ and ♀ mycelia and the formation of the basal wall of the oogonium, four specific substances are involved: two produced by the ♀ initiating specific responses in the ♂, and two produced by the ♂ bringing about specific reactions in the ♀. These hormones and their specific actions are summarized in Table 1:

TABLE 1*

Hormone	Produced by	Affecting	Specific action(s)
A	♀-vegetative hyphae	♂-vegetative hyphae	Induces formation of antheridial branches
B	♂-Antheridial branches	♀-Vegetative hyphae	Initiates the formation of oogonial initials
C	♀-Oogonial initials	♂-Antheridial branches	(1) Attracts antheridial branches (2) Induces, in connection with a thigmotropic response, the delimitation of antheridia
D	♂-Antheridia	♀-Oogonial initials	Brings about the delimitation of the oogonium by the formation of a basal wall

* See Fig. 1.

The evidence for these specific substances may be considered under a number of headings as follows:

(1) The sequence of events and the time intervals involved indicate a hormonal coordinating mechanism (see diagram). The time intervals may be varied by changing environmental conditions, but they always

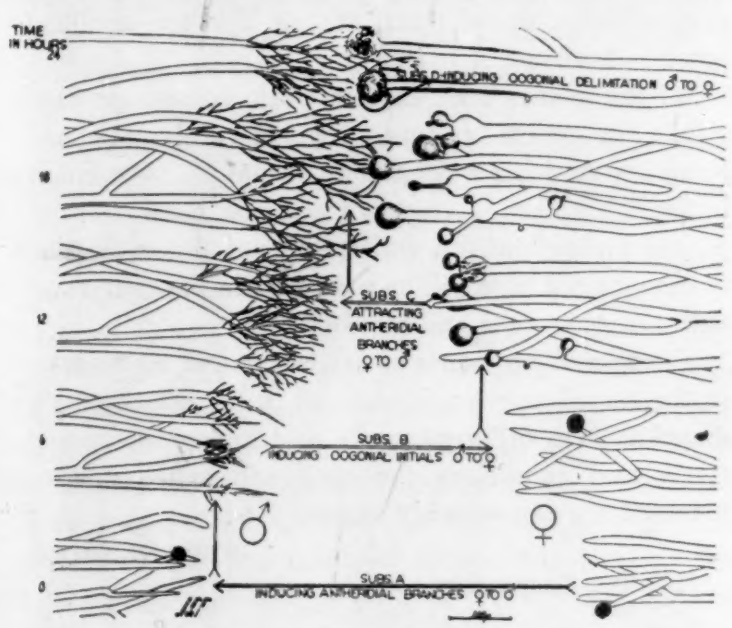

FIG. 1

remain proportionately the same and no change in the sequence has ever been observed.

(2) Telomorphotic (distance) responses regularly occur in both ♂ and ♀. (The formation of antheridial hyphae, the first step in sexual reaction, often occurs in a mating on a nutrient agar media when the ♂ and ♀ mycelia are as much as 6 mm apart, a distance 7.5 times greater than that shown in the accompanying diagram). These distance reactions, all essentially similar, have been observed in the following experi-

[1] Published with the approval of the Monograph Publication Committee, Oregon State College Research Paper No. 14.

[1] J. S. Huxley, *Biol. Rev.*, 10: 1935.

mental conditions: (*a*) In matings of ♂ and ♀ on various nutrient media; (*b*) in water culture matings; (*c*) in matings on agar in which the two sexually opposed strains were separated by a dialyzing Cellophane membrane; and finally (*d*) in single water cultures in water in which the opposite strain had previously grown, the water having been passed through a Seitz bacteriological filter. In this particular case a ♀ will only react when placed in water in which a ♂ has previously given the initial sexual reaction.

(3) The effects of variations in the composition of the medium offers a third body of evidence. By changing the composition of the medium the reaction can be stopped at times coinciding with the specific actions of the several hormones. These effects may depend either on the production of the substances involved or the ability of the opposed strains to react to them.

(4) Further evidence is furnished by interspecific matings between this species and *Achlya bisexualis* Coker. In each of the two reciprocal matings, *A. bisexualis* ♂ × *A. Sp.* ♀ and *A. bisexualis* ♀ × *A. Sp.* ♂, partial incompatibility is encountered. In the former the reaction stops at the time of differentiation of antheridia, while in the latter the female fails to produce oogonial initials in response to the substance produced by the exceedingly plentiful antheridial branches. These differences indicate a rather high degree of specificity of the hormones. Complete incompatibility would result if the ♂ were unable to react to hormone A of the ♀.

All the plants used in this work remain perfectly sterile in single culture, oogonia and antheridial branches forming only when ♀ and ♂ mycelia are brought together. Adequate controls have been employed throughout. A full account of the work which is summarized here will be published in the near future with complete data and methods.

The role of hormones as activators and coordinators in the sexual reaction is outlined in the accompanying diagram. On different media and under different experimental conditions the time and space intervals involved are considerably varied.

JOHN R. RAPER

HARVARD UNIVERSITY

VITAMIN C TREATMENT IN LEAD POISONING

IN a certain industrial plant where the lead hazard was exceptionally great, due largely to dust and spray, 400 workmen were examined clinically and with a differential blood count. About 40 per cent. showed distinct lead absorption or poisoning.

Of these 160, a group of 34 was selected for treatment with vitamin C (ascorbic or cevitamic acid), a treatment suggested by the bad condition of gums common to scurvy and severe lead poisoning. Half of this group was given 100 mg of vitamin C daily (but no extra calcium) for several weeks. With practically all of them there was a marked gain in vigor, color of skin, cheerfulness, blood picture, appetite and ability to sleep well. The basophilic aggregation test of Dr. C. P. McCord also indicated improvement. A typical case is reported below.

Workman Number One: Clinically diagnosed by one of us (E. J. A., a physician) as chronic lead poisoning. The man showed marked tremors, sleeplessness, a bad blood picture (differential count of white cells), nervousness. He was underweight and easily fatigued and had a sallow complexion. After five weeks of vitamin C treatment the tremors had disappeared, his complexion had greatly improved, his blood picture was encouraging, he enjoyed normal sleep, was cheerful and not easily tired.

The other half of the group of 34 continued their previous calcium gluconate treatment to drive toxic lead into the bones and supplemented this treatment with 100 mg vitamin C daily. They gained in health but not so well as the 17 men given vitamin C alone.

At this stage the research was transferred to Oberlin College, where 14 local house painters were examined. Judged by the combined evidence of a clinical examination and a differential blood count, half of these men showed enough lead absorption to call for treatment or greater precautions. Three of them were studied intensively for several weeks with careful analysis of urine for lead and vitamin C. Each was given 200 mg of vitamin C daily, in one case totaling 6,800 mg.

The chart for Painter Number One, as rather typical of all three, is reproduced here. This man, a painter and sprayer, was diagnosed by a physician experienced in observation of lead poisoning as a chronic case. After only four days of vitamin C treatment he felt pleasantly lazy and sleepy but not

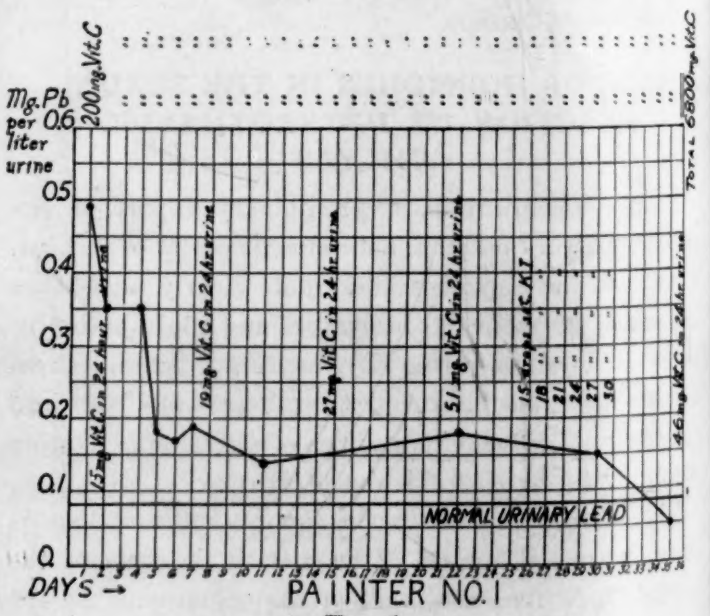

FIG. 1

tired. In a few days more he "felt fine," ready for work and fresh at the end of a hard day. The differential white cell count showed decided improvement, and lead excretion fell from nearly 0.5 mg per liter of urine to normal.

Four other painters, positively known to have selected for many years a diet unusually rich in vitamin C, were examined for lead and vitamin excretion in urine. Urinary lead was near that of the average man and vitamin C excretion high.

The conclusion, supported by test-tube experiment, is that vitamin C reacts with toxic lead ions to form a poorly ionized and much less toxic compound. Therefore lead destroys this vitamin, so necessary to buoyant health, while generous vitamin C supplements to the diet remove the lead from the field of action.

Any fear that the lead is stored dangerously by this reaction is met by Sollman's parallel observation that during deleading with potassium iodide, urinary lead generally decreases because the lead potassium iodide compound is absorbed by the liver and excreted in the feces with the aid of the bile. Analysis can justify a similar explanation for final disposal of the lead-vitamin C compound.

The obvious conclusion is that men exposed to lead hazard should be advised to include in their diet plenty of such rich sources of vitamin C as tomatoes (fresh or canned), raw cabbage, oranges or grapefruit, raw spinach (or even cooked, in very little water), raw turnips, green peppers, cantaloupe, etc. Or they may take 50 mg in a vitamin C tablet as an addition to the diet. The average healthy man excretes 25 to 35 mg vitamin C daily. Any excess intake is used to restore depleted reserves or is excreted.

A full report on this work is to be published in a medical journal later.

HARRY N. HOLMES
EDWARD J. AMBERG
KATHRYN CAMPBELL

OBERLIN COLLEGE

SCIENTIFIC APPARATUS AND LABORATORY METHODS

IRON HEMATOXYLIN STAIN CONTAINING HIGH CONCENTRATION OF FERROUS IRON

IN the study of some recently prepared permanent mounts of tissue cultures, a slightly modified Janssens' iron hematoxylin was used as a stain. This stain was made up as follows: Water 100 cc, ferric ammonium sulfate, violet crystals, 40 g, hematoxylin (pinkish brown powder when finely ground) 1 gram dissolved in 25 cc absolute methyl alcohol, glycerin 25 cc.

In one of these mounts it was noted that the cell nuclei were beautifully stained a clear, deep blue, absolutely free from the opacity sometimes met with in some poor iron hematoxylin stains. The cytoplasm, however, was stained a distinct brown color.

From the appearance of this preparation it seemed obvious that in the Janssens' stain there were two quite distinct staining agents. This was also strongly suggested by the color changes in the staining solution itself. This freshly prepared staining solution was always a clear, deep violet blue and was most vigorous in its action. After 24 hours, however, this color changed to a more and more marked yellow shade of brown and the solution lost some of its staining vigor. From these observations it seemed that the two staining agents were probably iron salts of hematoxylin in different stages of oxidation. The deep and unusually translucent blue of the nuclear stain was so selective and so sharp that it seemed highly desirable to obtain this stain in a more reliable form and without the complicating and relatively opaque brownish stain.

It seemed likely that the blue stain was from a relatively reduced form of the iron hematoxylin salt, while the brown was from a relatively oxidized form. On trial it was found that the fresh blue Janssens' hematoxylin could be changed to a brown solution by addition of hydrogen peroxide, while addition of a reducing agent, sodium sulfite, resulted in some resumption of the blue color in a solution of Janssens' hematoxylin, which had aged to a brown color.

With this confirmation two lots of hematoxylin were made up according to the above formula except that while the first used 40 grams of *ferric* ammonium sulfate crystals, the second used 40 grams of *ferrous* ammonium sulfate crystals. Of these the ferric ammonium sulfate solution showed the usual deep violet blue which in 24 hours changed to brown. The ferrous ammonium sulfate solution showed an extremely pale washed-out blue, which, however, did not change to the brown color at the end of several days. A third lot was then made up in which half of the iron salts was in the ferrous and half in the ferric form. In this solution 20 grams each of ferric and ferrous ammonium sulfate were used. The resultant solution at once assumed a deep rich blue, even deeper in color than the freshly prepared Janssens' hematoxylin. This solution was still a deep violet blue with only a trace of brown color at the end of a number of weeks.

Staining tests with this solution, which we are now using routinely for sections and for whole mounts of tissue cultures, have shown it to be a highly selective, clear, transparent blue nuclear stain which requires little or no differentiation other than soaking for a few minutes in a number of changes of distilled water

or in Van Giesen picrofuchsin. As an instance typical of the ease of use and reliability of the stain, a series of slides was stained for different lengths of time in a trial lot of this solution which contained only 10 grams each of ferrous and ferric alum, instead of the 20 as above described. The slides were then counterstained with Van Giesen picrofuchsin (5 minutes) in the usual manner. The slides stained 2 minutes were fairly satisfactory; those stained 4 minutes were nearly ideal; those stained 15 minutes could hardly be distinguished from those stained 4 minutes, and it was only when the staining was carried up to about an hour that the image showed signs of loss of detail from overstaining.

From these preliminary studies it is suggested that the combination of a high concentration of ferrous and ferric salts serves to maintain an oxidation reduction equilibrium in the solution which is far more suitable for the formation and preservation of the selective blue hematoxylin-iron salt than is either the ferrous or the ferric salt alone. It appears that the stain, above described, is highly selective. It is relatively insensitive to variation in staining time and may be used as practically a progressive stain with little or no differentiation. This differentiation, when required, may be done by time rather than by inspection. The solution is far more stable than either Weigert's or Janssens' hematoxylin, is easily prepared and does not require any aging. This stain has not given satisfactory results when used in contact with at least some metals, as, for instance, monel.

In conjunction with Dr. Ralph Lillie, of the division of pathology, a more detailed study of this stain is being carried on at this institute in order to more accurately define its properties. Even with the data above presented, however, the question is raised as to whether or not many, or possibly even all, of our current iron hematoxylin stains would not be substantially improved by substitution of a mixture of ferrous and ferric salts or some equivalent oxidation-reduction mixture for the ferric salts now in current use.

No studies have as yet been made on the action of this stain on such cell organs as mitochondria. These considerations will be left to a later date.

WILTON R. EARLE

NATIONAL CANCER INSTITUTE,
U. S. PUBLIC HEALTH SERVICE,
WASHINGTON, D. C.

"SPOTTING" SPECIMENS FOR CATALOGUE NUMBERS

ENAMEL spots for catalogue numbers on minerals and fossils have been superseded in this department for some years by spots of clear Duco cement. Applied direct from the tube, the cement is more convenient to handle than paint, and it hardens more rapidly. Its surface takes india ink well from a pen, and the inconspicuous character of the cement will be especially appreciated when numbers must be applied to transparent crystals.

A. S. WARTHIN, JR.

VASSAR COLLEGE

THE CARE OF SKULLS AND SKELETONS OF SMALL ANIMALS

BEFORE shipping small skulls and skeletons, or before allowing them to be cleaned by dermestid beetles, it is usually desirable to dry them as completely as possible.

The automobile, probably now used by the majority of collectors, makes an ideal desiccating machine. Small osteological specimens fastened under the hood by wire, in the hot air stream from the fan, become perfectly dry in a day or two, even in damp weather, if the automobile receives ordinary use. A minimum of preliminary cleaning is necessary, and brains need not be removed from skulls up to the size of a rat's. Enough muscle and tendon may be left on small skeletons to hold the bones firmly together. Fly eggs fail to hatch, and maggots quickly die under this treatment.

No claim to originality is made for this method, but it has proved so useful that it seems worthy of dissemination.

RICHARD M. BOND

NATIONAL PARK SERVICE
PORTLAND, OREGON

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